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ANALYSIS OF LEACHATE FROM INDUSTRIAL SOLID WASTE DISPOSAL SITES

MINISTRY OF THE ENVIRONMENT
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HAZARDOUS CONTAMINANTS OFFICE

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Ministry
of the
Environment

Ontario

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Analysis of Leachate from Industrial Solid Waste Disposal Sites

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There is an increasing awareness of environmental hazards associated with the disposal of industrial solid wastes. Several options may be available for method of disposal. Dumping at a landfill site is usually the cheapest, providing the material is in suitable form, possibly through pre-treatment.

Instances have been recorded of ground water contamination by industrial wastes containing chromium (6, 9, 49), cadmium (26), lead and mercury (8, 39).

In Minnesota, lead arsenate buried thirty years previously, resulted in lead poisoning in 1972. Similarly, arsenic wastes dumped over a 20 year period lead to 175 mg/l arsenic in ground water (46). In Ontario, elevated levels are being monitored in the Moira River (about 1 ppm) originating from abandoned mine tailings about 20 years ago.

High boron concentration (67 mg/l) was found in a small stream close to a private industrial dump close to the St. Lawrence River near Brockville.

Other recent instances in Ontario include the contamination of ground water by lead and sulphuric acid from a storage battery reclamation plant in Toronto and by vanadium, molybdenum, arsenic, sulphate and fluoride from a metal alloy processor in Ottawa. Iron (up to

240 mg/l) has been found in wells in Trenton. Chromium (30 mg/l) was present in spring water used for livestock and the source was traced to chrome plating waste illegally dumped in an abandoned gravel pit. High chloride (over 1000 mg/l) was found in wells in the vicinity of salt dumped in the Ottawa area.

Contamination of lake waters by acid, heavy metals, sulphate and ammonia from acid mine wastes in the Manitouwadge area of Ontario was described by German (13) at the last Industrial Waste Conference. High concentrations of nickel (3 mg/l) and aluminum (6 mg/l) were detected in wells in the Sudbury area.

Stored industrial wastes can also lead directly to air pollution. An interesting case followed by the Ministry was the generation of the highly poisonous gas phosphine (PH_3) from a slag stored (and even spread on the grass) on the grounds of a small aluminum foundry in Toronto.

Many industrial wastes are organic. Assessment is normally by general tests on leachate such as BOD, COD and phenols. An example is the very high BOD and COD associated with sugar refinery waste previously dumped along the Toronto water front.

Pesticides and chlorinated hydrocarbons can also cause serious environmental problems. Polychlorinated biphenols were detected in an auto manufacturing filter pre-coat waste by the Ministry of the Environment.

Potential hazards from different types of manufacturing operations have been described (46). The more hazardous inorganic substances are arsenic, cadmium, chromium, copper, cyanide, lead, mercury and selenium.

A much larger quantity of municipal refuse than industrial wastes has to be disposed of and the leachate from the former can also cause serious environmental problems. Industrial leachates should, therefore, be viewed in the perspective of municipal leachate.

Considerable experimental work has been conducted on the leaching of municipal refuse and mixtures of soil and sewage sludge in the field and laboratory, often for extended periods. In contrast, there is little literature on small scale leaching tests for industrial waste, possibly because of the wide range of composition and local rather than general problem situations. Recently, however, interest has developed in leaching studies on fly ash from thermal power generating stations with a view to finding uses for this abundant waste product.

Since some solid or semi-solid industrial wastes may be mixed with municipal wastes and soil, and to better understand some of the problems and complexities of leaching tests, it is useful to consider chemical and biological interactions within the site.

COMPOSITION OF LEACHATE AND GAS

An excellent paper on the high pollutant potential of leachate from sanitary landfills was given by Rovers, Nunan and Farquhar at the 21st Ontario Industrial Waste Conference (35).

It was commented at the International Round Table Conference on Leachate Analysis, Vancouver, B.C., April, 1975 (10) that there was high toxicity of leachate to fish, especially so if it was acidic. Toxicity occurred at .062% by volume (96 hr TL_M).

Some heavy metals appear in leachate, sometimes in fluctuating concentration, as for copper. Usually, there is a delay before their appearance as noted for iron, nickel, zinc and copper (11).

An appreciable amount of zinc is usually found in leachate, 0.8 mg/l was reported for an old landfill site in Waterloo, Ontario (12, 33) and 2 mg/l in an Oceanside, California study (44). Iron and magnesium occur in variable concentrations (Fe to 25 mg/l; Mg to 81 mg/l). Selenium is often present, as it is used in most paper products (18).

The slow rate of bio-degradation of most organic refuse even after nine to twenty years (43) affects lachate composition. Rovers et al (35) showed that the release of COD, chloride and total Kjeldahl nitrogen depends on the quantity of leachate which, in turn, depends on the water present initially and added by infiltration.

Temperature appears to affect the species of bacteria, affecting COD, pH, total solids and phenolphthalein acidity (26, 28).

Decomposition appears to occur in two phases. In the initial acidifying step bacteria metabolizes fats, proteins and carbohydrates to fatty acids and simple organic acids. In the subsequent deacidifying step organic acids are converted by methane forming bacteria into methane and carbon dioxide.

Generation, composition and movement of land fill gas are also important (11). Methane increases in concentration with age of site as conditions change from aerobic to anaerobic. Hydrogen sulphide can be generated, particularly if the waste contains sulphate, such as gypsum (11).

Organic compounds are usually rapidly attenuated in the soil, as indicated by BOD, whereas some inorganic species, such as chloride, resist attenuation (2, 34, 52).

Soil materials behave like ion exchange resins with ion exchange capacities and "break-through" points, resulting in leachate attenuation until chemically saturated (34). There is also a filtering action, removing suspended solids and reducing permeability and thereby further leachate movement. Chemical precipitation and co-precipitation, gaseous exchange and microbial action can be involved (25).

There is minimum impact in the local environment if leachate is discharged into a municipal sanitary sewer system. Leachate can be recycled or contained. However, liners have not been found completely effective to date; hence location of a site in a soil with good attenuation properties is necessary.

Deep silts, clays and shales are usually preferred with limstone and gravel rarely acceptable (43). Minimum depth to the water table is important.

In Pennsylvania, some toxic industrial wastes unsuitable for incineration are only acceptable after processing to retard leaching if encapsulated in the disposal site in a relatively impermeable cell surrounded by a layer of lime or finely crushed limestone.

Industrial wastes can be made more suitable for disposal by treatments such as dewatering, mixing with a relatively inert water such as fly ash or "fixing" by proprietary processes such as "Chem-Fix" of Environmental Sciences Inc., Pittsburgh or that of Chem-Met Disposals, Wyandotte. Sulphides, calcium carbonate and gypsum are often included with organic additives.

LABORATORY TESTS

The laboratory is involved in both site selection and evaluation of solid wastes. Because of the complex nature of leachate generation and the heterogeneity of wastes, most studies have been conducted in the field in test cells (44) or by using large lysimeters in the laboratory (11, 34).

A large number of inter-related factors affect leachate compositions.

It is obviously difficult to simulate disposal site conditions in a small scale laboratory test. In order to obtain uniformity it is usual to leach with distilled water in a column or by a "shake" test but there are serious limitations necessitating considerable judgement in the interpretation and application of data.

Rovers and Farquhar studied the capacity of soil to remove contaminants by the use of sealable acrylic columns which could be filled with undisturbed soil using a Shelby tube (34). Leachate was supplied from a simulated land fill. A quick small scale test was devised by shaking soil with leachate in Ehlenmeyer flasks for different lengths of time.

The use of distilled water as a leaching liquor has the advantages of excluding many unknown factors and permitting standardization. However, even for distilled water, there are large differences in solvent properties depending on whether there is continuous contact with fresh water as in a column percolation test or if the solute is not removed, as in shake or static tests.

Another important factor is whether the sample is disturbed (shake tests) or undisturbed (column and shake test). This is not as important in finely divided intervals such as fly ash or foundry sand but becomes highly critical if the material is in hard lumps or cemented. Obtaining undisturbed samples of most material in a core is difficult, particularly in a narrow cylinder, and there is always the possibility of channeling through cracks or at the edges of the cylinder. In some instances, a bacterial slime can develop preventing flow. If lumps are pulverized there is a large increase in surface area available for leaching. Abrasion of particles can also occur during the shake test. Even drying a sample can change its leaching characteristics.

A problem with "undisturbed" samples is that it is difficult to obtain a truly representative sample unless it is large, whereas if it is pulverized and blended this difficulty is overcome.

One possiblity is to leach narrow range size fractions and interpret the data based on size distribution and surface area considerations. This would permit comparison of tests and some indication of severer conditions such as the crushing of wastes during handling operations.

With large lumps it is not possible to conduct small scale column or shaking tests. Some indication can be obtained by immersing the material in the leaching liquor under static conditions, agitated or contacted with fresh liquor through the use of a pump.

The lumps can be cut or pulverized to a certain size to permit standardization but this can change surface effects.

A rough surface, such as presented by a scoriacious slag, provides a large surface area for solution effects.

In a landfill site conditions are very different from distilled water contact. Soluble organic compounds (usually acidic) are produced which can transport many metals as chelates. Gases such as carbon dioxide and hydrogen sulphide can react chemically, accelerating solution or precipitation. Conditions can change from aerobic to anaerobic. There can be intense micro-organic activity or minimal due to toxins introduced with the waste or developing later. Water can be in abundant supply or restricted. Leachate and gas may be retained within the site by an impermeable seal or by low porosity of the compacted waste and fill.

An attempt can be made to simulate the

internal environment of the site by leaching with weak organic solutions such as acetic acid or neutral or acidified ammonium acetate. Ethylene diamine tetra acetic acid (EDTA) can be used as a chelating agent. The use of similuated rainwater can sometimes more closely duplicate natural conditions. If present in significant concentrations in rainwater, sulphur dioxide can have a larger effect than carbon dioxide. However, in a landfill site with decaying organic refuse, carbon dioxide will have a significant role. Methane is considered to be chemically inert.

A problem with the use of simulated rain is the high variability in composition of rainfall with location a major factor. Dr. Kramer's group at McMaster University has found the rain in Hamilton to be slightly alkaline where as in Sudbury it is acidic. Attempts have been made to "simulate" rain by adding sodium bisulphite or bicarbonate. This route is not as satisfactory as bubbling carbon dioxide into water because the sodium ion may modify the properties of the material.

In some instances, analysis of the liquor associated with the solid is important with respect to disposal of the waste as it may have a larger effect on the leachate than the solid fraction.

Microbial action should not be ignored particularly if metals such as mercury or lead which can be methylated are present in the waste. "Fixing" the metal such as in the sulphide form will retard leaching initially but in the long term there may be slow release of the methylated forms and/or chemical or bacterial conversion to the more soluble sulphate. The maintenance of an aerobic or anaerobic internal environment, nutrient supply and presence of toxins will have major effects on biological acitivity. If the waste is inter-layered with fill biological activity could be very significant.

The type of test conducted is, therefore, highly dependent on the nature of the waste, physically and chemically. It is usually advisable to perform a total chemical analysis prior to a leach test to determine what parameters are likely to be important.

Choice of leach liquor has, of course, a major effect on the concentration of ions in the leachate. This has been observed in MOE studies and in the shake test on fly ash using water and EDTA extractants reported by Theis (41). Of interest, was the high arsenic in the EDTA leachate compared with water.

LABORATORY LEACHING PROCEDURES

Environmental Sciences Inc. developed a leaching test in connection with the evaluation of Chem-Fix treated waste*. It was felt that only a steady state percolation test on relatively undisturbed material should be used to predict long term effects of leaching. The results of 400 leaching tests compared favourably with field data. Results were submitted to EPA and met with their approval in each case.

One hundred grams from a core of material is placed in a 40 x 600 mm chromatography column. Water is percolated through the column at a rate of 1 ml per minute and collected in 100 ml portions. Up to 32 cuts are collected. Each 800 mls simulates 25 inches of ground water passing through the material in the field.

The procedure has been used in industry, such as in the testing of mercury leached from "Chem-Fix" treated sludge in Thunder Bay, Ontario, in which the material was leached for the equivalent of 25 years, assuming one third of the rainfall infiltrated through the solid waste. A similar procedure was used by the Ontario Research Foundation for a foundry sand.

A shake test has been developed for leaching fly ash (48). Five hundred grams of ash are shaken with 2 litres of distilled water for 48 hours and the supernatant liquor analyzed. EDTA was also used as an extraction.

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* Chemfix Division of Environmental Sciences Inc. Leaching Tests for Solids Developed from Treatment of Industrial Wastes. Data Sheet 105. Environ. Sci. 505 McNeilly Rd., Pittsburgh, Pa. 15226.

Shaking tests have been used for many years for measuring available nutrients for plant growth in soils analysis, using extractants such as ammonium acetate, acetic acid or EDTA, usually in a 1:4 ratio.

ONTARIO MINISTRY OF ENVIRONMENT TEST PROCEDURES

Various procedures have been used in the MOE Central Laboratory during the past two years depending on the availability of equipment and time, sample size and characteristics and intended disposition of the waste. Attempts were made to simulate natural conditions by column percolation tests and used leaching solutions such as simulated rainwater with bisulphite, neutral and acidified (pH 4.8) ammonium acetate, acetic acid and EDTA. These have been used to determine "available" or "extractable" inorganic species in agriculture. One per cent sodium hydroxide was used as an extractant for phenols. To obtain a rapid assessment of the severity of pollutant potential a "shake" test was devised using the same extractants as for the column tests. A ratio of 1:50 was selected principally on the basis of recent laboratory experience with extractable phosphorus.

0.5 N sulfuric acid was also used to asses the effect of contact with acidic waste. Leachate was analyzed principally for heavy metals because of the limited volume available.

In the earlier MOE studies' column tests the waste sample was taken As-Is, using as much material as practicable (usually 100 gm). This was partly dictated by the need for an adequate volume and concentration of leachate for analysis. A simple constant head device was used for leach liquor with inverted 500 ml volumetric flasks and leach rate controlled by a screw clamp at the exit of the column. Two 500 ml cuts were usually collected, each representing 8 inches of ground water.

Some of the earlier work at the Ministry of the Environment Central Laboratory was to follow up on the leaching of "Chem-Fix" treated mercury sludge using the column percolation procedure. Biological activitiy was stimulated by leaching with nutrient rich water (BOD water) seeded with bacterially active river mud. The test was continued for an extended period. Conditions were partially aerobic through air bubbling into a constant head device.

The shake test involved extracting 1 gm dried pulverized waste with 50 ml leach liquor for 15 minutes on a wrist-action shaker and repeating for a second cut. Limitations of the test were recognized. Consideration was given to adopting the fly ash shake test procedure with a 1:4 solid:liquor ratio.

Recent acquisition of Technicon pump and fraction collector has permitted development of a more satisfactory percolation test. The collector has a capacity of four rows of fifty 25 ml tubes and a 30 minute timer. The pump permits controlled flow of leach liquor and gas. Four samples can be run simultaneously for up to 50 cuts or one sample can be run for up to 200 cuts (83 hours) with little attention. It is also possible to introduce gas at controlled flow.

Narrow plastic columns were first used with 10 to 25 grams wet weight, percolated with 1 ml per minute of leach liquor. For some materials of fine particle-size or heterogenous composition there were problems of insufficient volume of leachate, leaks, channeling or non-representativeness. A clear acrylic tube holding 500 gm or more of material (usually 6-7 in. column) was found more satisfactory. Pump tube size had adjusted to provide a flow rate at or below the permeability rate for the material or a maximum of 1 ml/min.

It was possible to obtain an indication of the volume of water needed to saturate the material before leachate flow and permeability, both important is assessing the effect of a waste on leachate production. Gas flows could also be controlled by Technicon pumps.

Since carbon dioxide appears to be the most important reactive gas in most landfills, occurring sometimes up to 50% by volume, it was decided to conduct leaching tests with distilled water, treated with carbon dioxide and either air or nitrogen. Usually air was first pumped into the column followed by nitrogen. Carbon dioxide was generated from marble chips and 6 N sulphuric acid.

Nitrogen was simply prepared by passing air through pyrogallol solution. The gases can be mixed with the water flow prior to entering the solid waste column directly or after collection in a reservoir. The pH of the distilled water/carbon dioxide/air solution remained constant at 4.7 under the conditions of the test.

Leachate cuts are tested for pH and conductivitiy to help determine the frequency of testing for parameters of interest. Cuts are analysed more frequuently in the region of maximum curvature in the leach curve. Where the slope is uniform and linear cuts can be composited for analyses requiring a larger volume.

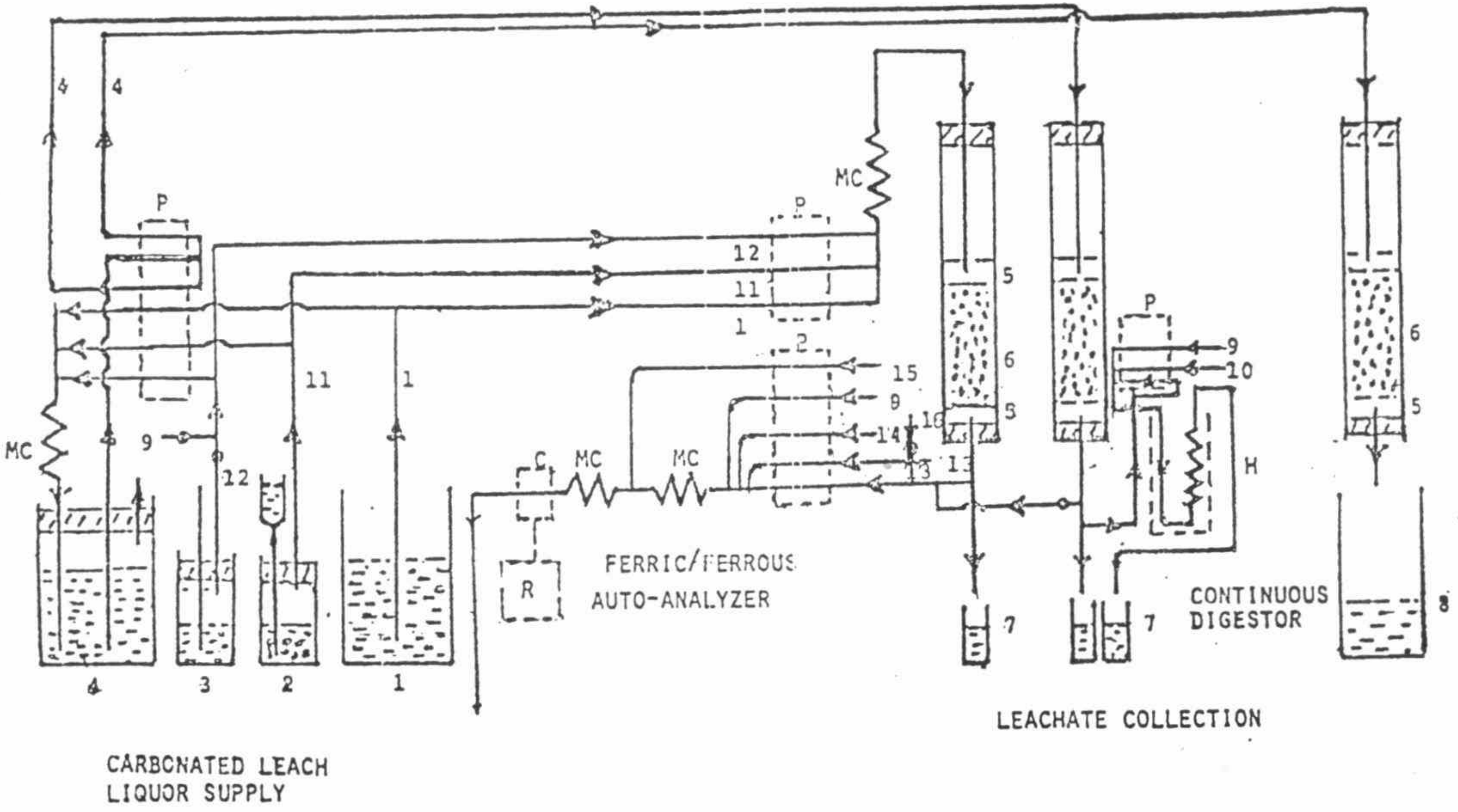
Present practice, if there is sufficient material, is to set up two columns with 500 grams of the waste. The leachate from one column is not preserved for measurement of anions. Conductivity and pH are currently monitored manually; continuous monitors could be installed. The effluent is split with one stream analyzed for ferrous and total iron on a continuous or intermittent basis using a o-phenanthroline with/without hydroxylamine. The ferrous/total iron ratio is used as an estimate of Redox conditions in the column.

Leachate for the second column is treated with aqua regia at 95°C in a continuous digestor for digestion and AAS analysis on selected cuts.

With the 2 in. I.D. column 51.5 ml leachate corresponds with 1 inch of water infiltering the waste. With 1 ml/min. flow rate this corresponds with 19.5 in. infiltering water in 50 cuts collected over 16.7 hours. If it is assumed that one third of the rainfall penetrates the mass this is equivalent to about 50 inches rainfall (about two years). With wastes of low permeability the volume of infiltrated water is less; however, the ratio of infiltration to rainwater is probably wider. Some tests are being run for over five years rainfall equivalent.

Since the presence of organic matter has a profound effect on the composition of leachate at least for some types of industrial waste, such as foundry sand, due to the formation of organo-metallic and hydroxy complexes, present practice is to follow the first phase of the test on the same waste material by replacing the distilled water with organic leach liquor. Ammonium acetate 1 N, adjusted to pH 4.8, appears to be satisfactory, particularly as this reagent has been widely used for the measurement of extractable metals. Other reagents, such as acetic acid, EDTA, natural landfill leachates or humates, will also be evaluated. Dilute sulphuric acid will be used in some instances such as in cases where the waste would come in contact with more highly acidic waste or in areas of acidic rainfall.

FIGURE 1 SOLID WASTE LEACHING SYSTEM



LEGEND

1. DISTILLED WATER OR EDTA, ETC
2. CO_2 GENERATOR (KIPPS)
3. DEOXYGENATOR (PYROGALLOL)
4. CO_2-AIR/N_2 WATER
5. GLASS WOOL
6. SOLID WASTE
7. VIALS (FRACTION COLLECTOR)
LEACHATE

9. AIR
10. HNO_3/HCL
11. CO_2
12. N_2
13. HYDROXYLAMINE HCL
14. PHENANTHROLINE
15. BUFFER

P PUMP-TECHNICON
H HEATING BATH
C COLORIMETER-TECHNICON
R RECORDER
MC MIXING COIL

RESULTS OF LEACH TESTS

The older version of column leach test was used for most of the earlier samples of solid waste studied at the MOE Central Laboratory, using distilled water, 2.5% acetic acid and .005 N EDTA leach liquor. A wide range of waste types were handled ranging from sugar refinery waste to foundry sand. Analyses were run chiefly for the more common heavy metals and conductivity and pH in the water extracts. BOD and COD were analyzed on organic wastes. Of interest was the high iron and aluminum in a foundry sand, even in a water extract. Concentrations were much higher in the acetic acid extract.

There were also instances of high phenols (17 mg/l) and high BOD and COD (6000- 9000 mg/l).

In the Shake Test high concentrations of aluminum were released from an alum plant mud, high manganese from a foundry waste and high chromium from a chrome sulphonator sludge.

Analysis of the water associated with the solid waste was felt to be a good indicator in a lagoon sludge and leather processing waste. High ammonia and sulphide concentrations were found in the lagoon and high total sulphur, BOD, COD and conductivity in the leather waste.

There was a wide range in pH for some leachates. Alum plant mud and foundry sand were highly acidic whereas black liquor was strongly alkaline.

Note was made of the colour of the leachate and the presence or absence of turbidity after settling. Strong amber or brown colours were produced in ammonium acetate leachate of foundry sand.

Laboratory data for some leaching tests using the older column method and the shake test for those metals released in significant amounts are given in Tables 1 and 2. Concentrations are expressed as mg/l in the leachate and as ug/g (p.p.m.) calculated back to the dry weight of material used.

It is evident from the column leach tests on filtered wastes (Table 1) that much higher concentrations of zinc and iron were released by acetic acid compared with water. EDTA was less effective, possibly because of the low concentration used. Further work will be conducted with 0.05 N EDTA, a concentration which is widely used by other workers.

In the shake tests (Table 2) it is again evident that acetic acid released much more aluminum, chromium and iron than water. Ammonium acetate had little effect, probably because it was at pH 7 rather than at pH 4.8 as used later in a column leach test on foundry sand. Acetic acid followed two 500 ml cuts of ammonium acetate with little further release of iron, zinc and manganese. Sulphuric acid released more aluminum than acetic acid from alum plant mud, particularly from the second cut, indicating it was dissolving less soluble forms.

Unfortunately, the material used in the earlier column tests was not available for shake tests hence no direct comparison is available. The types of waste evaluated were also very different.

Only a limited amount of work has been done to date with the large acrylic columns and fraction collector system. Leaching studies are being conducted with foundry sand samples initially with distilled water mixed with carbon dioxide and air followed by carbon dioxide and nitrogen. Following prolonged leaching the water is replaced with 1 N ammonium acetate at pH 4.8.

The distilled water leachate was alkaline (pH 9 to pH 12) throughout the test for the equivalent of 80 inches of rainfall with high conductivity initially in some samples. Only trace concentrations of iron, copper and zinc were released. The leachate from one sample was initially pale brown in colour and in others there was a colloidal suspension. Changing from aerobic to anaerobic conditions (from air to nitrogen) seemed to have little effect. In some samples the change-over from distilled water to ammonium acetate was most dramatic. Leachate colour changed to dark amber or yellowish brown and iron and manganese concentrations from under 1 mg/l to several hundred.

This study demonstrated that prolonged leaching with distilled water even acidified with carbonic acid gives no indication of the effect of organic chelates, at least for foundry sand wastes. It may give some indication of leachate which could result from exposure only to normal rain water. If this type of material is to be disposed of in a landfill site a carbonated distilled water leach is obviously not adequate for characterizing the environmental hazard. Search is continuing for a completely satisfactory leach procedure.

Column and shake leach tests are also planned for heat processed sewage treatment plant digested sludge and thermal generating station fly ash.

FIGURE 2

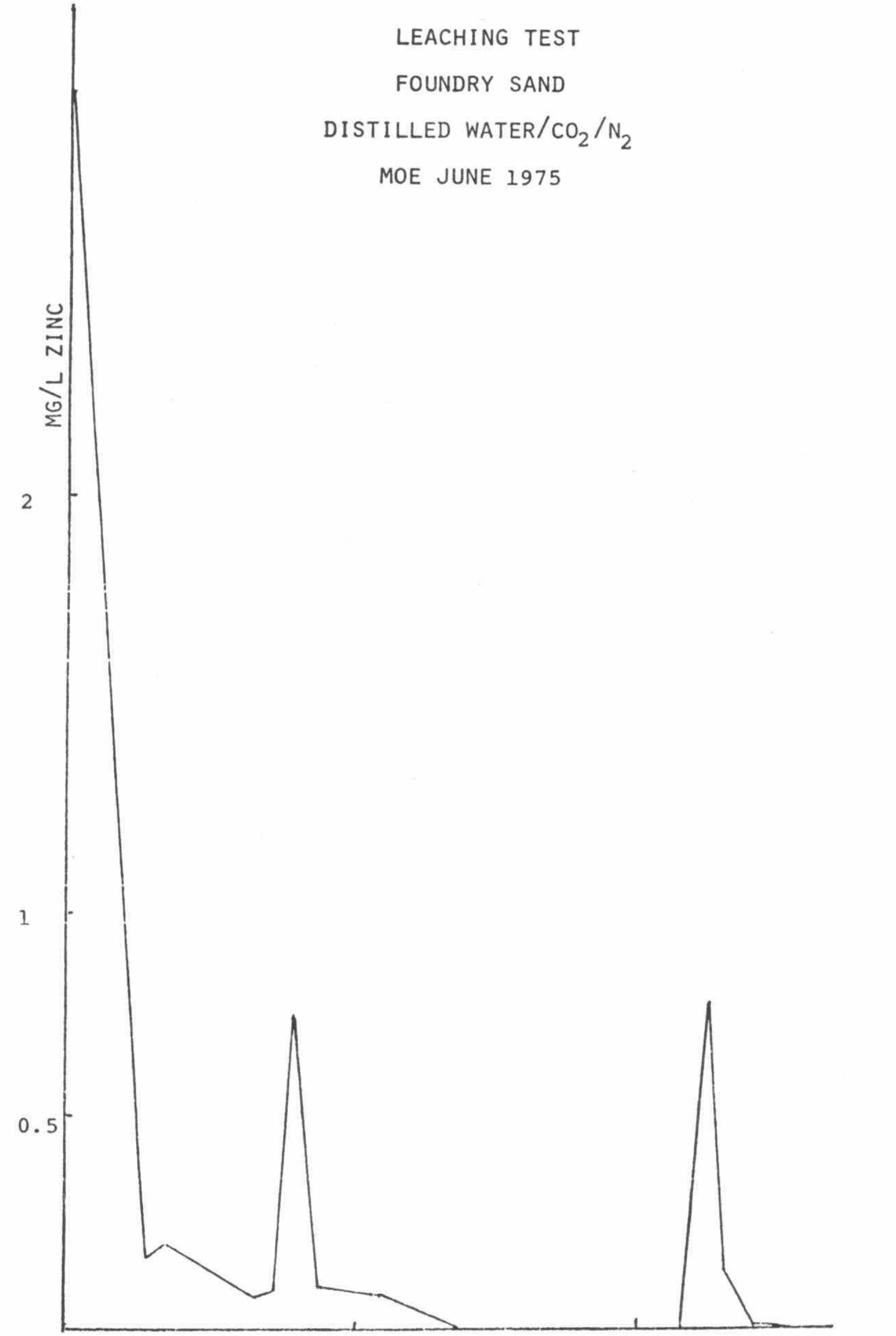

LEACHING TEST
FOUNDRY SAND
DISTILLED WATER/CO_2/N_2
MOE JUNE 1975
MG/L ZINC
2
1
0.5
0
60
30
120
60
CUTS
INCHES RAINFALL EQUIVALENT

TABLE 1 CONT'D	TOTAL ANALYSIS DRY WT BASIS UG/G	WATER UG/G	WATER MG/L	ACETIC ACID 2.5 % UG/G	ACETIC ACID 2.5 % MG/L	EDTA .005 N UG/G	EDTA .005 N MG/L
FILTER WASTE AUTOMOTIVE		ZN 2.5	.4	ZN(1) 1953	295	253	38
				(2) 748	113	107	16
				(3) 232	35	180	27
	FE 45000 ZN 3890						
		FE 9	1.4	FE(1) 5144	777	231	35
	PB 1395			(2) 5925	895	293	44
				(3) 2688	406	353	53
		PH 5.7					
				MN(1) 659	100	90	14
		COND 290 MMHOS		(2) 318	48	50	8
				(3) 152	23	94	14
				PB(1) 106	16	79	12
				159	24	37	5.6
				96	14	50	7.5
SUGAR WASTE		BOD (1)	6500				
		(2)	100				
		COD (1)	8600				
		(2)	100				
		PH (1)	6.4				
		(2)	7.2				

* (1) & (2) 1ST & 2ND 500 ML CUTS, RESPECTIVELY

TABLE 1 ANALYSIS OF LEACHATES

COLUMN LEACH TEST - 100 GM WET WT/500ML

WASTE	TOTAL ANALYSIS DRY WT BASIS UG/G	WATER		ACETIC ACID 2.5 %		EDTA .005N	
		UG/G	MG/L	UG/G	MG/L	UG/G	MG/L
BULK CARRIER		pH 6.9		AL(1)* 45800	1020	AL 411	9.1
				(2)* 15400	340		
		COND 740 MMHOS		FE(1) 269	6	FE 18	.4
				(2) 49	1		
PRE-COAT FILTER AUTO MNF.		ZN(1) 45	3.3	ZN(1) 676	50	ZN(1) 49	3.6
		(2) 76	5.6	(2) 163	12	(2) 33	2.4
	ZN 5500						
	PB 3085 CR 899	PB(1) 35	2.6	PB(1) 42	3.1	43	3.2
	PHENOL 7.2	(2) 24	1.8	(2)19	1.4	43	3.2
		pH 11.8					
	PCB 0.5	COND 5800 MMHOS					
		PHENOLS 350 PPB					
FILTERED SLUDGE FIBRE GLASS		COND 690 MMHOS		AL 6.6	0.6		
	AL 6870 CA 22300 FE 2175 MG 1915	pH 8.1		ZN 5.4	0.5		
		PHENOLS 17000					

ANALYSIS OF LEACHATES

TABLE 2

SHAKE TEST - 1 G/ 50 ML - 15 MIN.

	TOTAL ANAL.	WATER			AMM - ACETATE IN			ACETIC ACID			SULPHURIC ACID 0.5 N			LIQU FRACTI OF WAS
			UG/G	MG/L		UG/G	MG/L		UG/G	MG/L		UG/G	MG/L	
ALUM PLANT MUD	AL 28.1 MG/G	AL (1)	965	9.3	AL (1)	33	0.7	AL (1)	1715	34	AL (1)	2365	47	
		(2)	110	2.2	(2)	31	0.6	(2)	495	9.9	(2)	1250	24	
		ZN (1)	21	0.4							FE (1)	290	6	
		(2)	4	.08							(2)	950	19	
		PH	3.4								ZN (1)	30	.6	
			4.0								(2)	27	.5	
FOUNDRY WASTE MALLEABLE IRON	MN 3500 UG/G	FE	417	8.3	MN	35	0.7				MN	3000	60	
		PH	7.7-7.8											
CHROME SULPHONATOR SLUDGE	CR 7400 UG/G	CR (1)	250	4.9	CR (1)	560	11.2	CR	5500	110				
		(2)	19	0.4	(2)	247	5.0							
	FE 5600 UG/G	FE (1)	26.5	0.5	FE (1)	23	0.5	FE	3000	60				
		(2)	9.0	0.2	(2)	17	0.3							
		PH	7.5,7.8											
LAGOON SLUDGE (LINDSAY)	FE 2000 UG/G	FE (1)	3.5	.07	FE	12	.2							150 MG H_2S & 150 MG NH_3 AS
	H_2S 644 UG/G	(2)	4.0	.08	ZN	22	.4							
					MN	14	.3							
		PH	11.3											
LEATHER WASTE		COND	4200 MMHOS											TOTA SULPHU 1100 MG

BOD 2400

COD 4600

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